

The Canadian Entomologist.

LXXVI

JUNE, 1944

No. 6

COLOUR CHANGES IN *MANTIS RELIGIOSA* L.*

BY H. G. JAMES,

Belleville, Ontario.

The literature contains many references to the close resemblance of various Orthoptera to the colour of the vegetation and soil on which they occur. Hancock (1911) noted this particularly with the acridid *Dissosteira carolina* (Linn.) and attempted to determine whether this species changes colour at the critical stage of the last moult. From his experiments he concluded that the Carolina locust does not change abruptly from one colour to another during the critical period following ecdysis, but that the change takes place gradually. To account for the colour change he indicated that the hypodermal cells lying in the integument of the newly-moulted adult are very sensitive to light and humidity, and respond by changing colour in accordance with that of the habitat. This explanation is similar to the one proposed by Vosseler in 1902.

More recently Faure (1932) cited evidence to show that colour changes in *Locustana pardalina* (Walk.) often occurred between moults and were not due to the effect of the background on the newly moulted insect, while in the pre-hardened state. This locust, in its various colour forms, tends strongly to resemble the plant or soil background. Faure also conducted an extensive series of experiments with hoppers confined to boxes of different colors. As a result he was able to produce experimentally hoppers and adults similar to those occurring in the field, with the exception of the green form. In order to obtain the latter an abundant supply of succulent food and a humid atmosphere were the necessary requirements. Under the best conditions, however, only about 70 per cent of the hoppers could be changed to green, indicating that perhaps a genetic factor also was involved.

In connection with the strictly carnivorous *Mantis religiosa* L., Rabaud (1926) reported that in France the proportion of green and brown individuals was subject to considerable variation. In his own district between 80 and 85 per cent were present in the green phase. He also recorded that in one instance a green mantis nymph changed to a brown adult a few hours after moulting had occurred on brown wood. This supported his view that the final colour of the mantis depended upon the colour of the substratum on which the insect was stationed at the time of moulting and during the hours that follow.

Since 1940 the writer has been recording the distribution of colour forms of the same species in the region around Belleville, Ont., where the mantis is well established and in some years very abundant. At Belleville proper, two fields on the outskirts of the town, each about three acres in area, were selected as being most suitable for this study. Field No. 1 is part of a larger uncultivated area comprising a gradual but well-drained slope to the south. During early summer the dominant colour of this field is green, but later in many places, particularly if the season is dry, the green is replaced by the yellow and brown tones of maturing grasses and other plants. The result is a background of vegetation which is either uniformly brown or a mixture of browns and greens, such as for instance, occurs in a stand of maturing grasses in which new growth is springing up. The mantids recorded from Field No. 1 were present in both

* Contribution No. 2281, Division of Entomology, Science Service, Department of Agriculture, Ottawa, Canada.

the green and brown phases in the adult stage, and also apparently in all nymphal instars except the first and second (Table 1). In the same field during the summer of 1942 the colour of all the individuals seen was compared as objectively as possible with that of their plant background. As a result it was found that the mantids agreed more often than not with the colour of the vegetation, especially if the colour of the latter was uniform (Table 2). In certain cases, however, the substratum could not be described satisfactorily owing to the character of the growth itself which might reflect shades of both colours.

TABLE 1

Individuals of Two Colour Phases of *M. religiosa*
Recorded at Belleville

Year	Field No. 1				Field No. 2			
	No. Records	Brown Mantids	Green Mantids	% Green	No. Records	Brown Mantids	Green Mantids	% Green
1941	123	61	62	50.4	15	0	15	100.0
1942	76	36	40	52.6	41	2*	39	95.1
1943	33	10	23	69.7	61	1**	60	98.4

*brown males

**second instar nymph

In contrast to the first field, Field No. 2 is situated in low ground which is subject to considerable flooding in the spring and also shows evidence of a high water table until the end of July. The plot is rectangular in outline, and as concerns all mantids except the adult males which fly readily, is isolated on three sides by barriers, namely, dense shrubs and woods to the east, a drainage ditch to the south and a raised paved roadway on the west. The northern boundary is on somewhat higher ground and includes dwellings and cultivated land. Green is the prevailing colour of this pasture from June until the middle of August. Not until September when some of the grasses are maturing is there much yellow and brown coloration. The lower parts of the herbage near the ground, however, remain definitely green. All the mantids recorded from this field except three were green, and appeared to agree with the colour of their plant substratum (Table 1). The exceptions were two adult brown males observed in September, and a second instar brown nymph seen on July 7. It is not unlikely, however, that the males flew into the field from some other point. As for the brown nymph, one would hardly consider it as an exception in this case since it was probably one which was late in hatching*. Brown is the usual colour of second instar** nymphs a few hours after their emergence from the ootheca. The sex ratio of the nymphs in the same field was approximately 50:50 during July, but later in August as the mantids became sexually mature, it increased in favour of the females. This may be due in part to the cannibalistic behaviour of the females while pairing.

TABLE 2

The Colour of Individual Mantids as Compared to that of the
Plant Substratum in Field No. 1

Year	Total No. Records	Positive	+	Negative	Mixed Background	
					No.	%
1941	114	63	55.3	19	32	28.0
1942	108	57	52.8	22	29	26.8

Green mantids were also in the majority at Chatterton, Ont., in fields comprising both higher and low pasture lands with no apparent barriers

* Hatching in Field No. 1 occurred between June 21 and June 28 in 1942.

** After Pagenstecher's terminology.

nphal
g the
ective-
d that
n, es-
cases,
char-

separating them. In the long grasses on the elevated ground, green individuals averaged 58.7 per cent, while those on the low ground reached 82.1 per cent of the total. In addition to the colour forms already noted, several of the mantids were transitional in colour, varying between tawny and olive-green. These were recorded between August 5 and 26. Three adult mantids in the olive-green phase were also observed by the writer on August 20 in a maturing stand of timothy at Belleville. A week later, however, none in this phase could be found at the same point.

It would appear from the above data that the colour of the mantids, with the exception of adult males, bears some relation to the condition of the vegetative cover. If the latter is altered throughout the season by the weather, corresponding colour changes occur in the mantids, appearing first as transitional colours and ending in the familiar bright green or in the brown phase. Whether the response of the insect is due directly to the colour of the plant cover or is brought about by other physical factors of the environment is a point open to question.

Evidence that the colour of the background is of importance was first obtained in 1942 from a number of female nymphs collected in the pre-adult instar from the two fields at Belleville already mentioned. The mantids were placed singly in small wooden cages. These had cotton backs and glass fronts, and the remaining inside surfaces were lined either with brown pasteboard or with green blotting paper. All of the insects were reared in the insectary at Belleville where they were exposed to the same conditions of humidity, temperature, and illumination. Field crickets were fed daily to the mantids although no attempt was made to standardize the food factor in the experiment. Under these conditions five of the eight mantids from Field No. 2 changed from green nymphs to brown adults while in the brown cages. The colour changes followed ecdysis, were gradual, and required from six to seventeen days. A transitional olive-green phase was also noted. Two of the originally green nymphs did not change at all, while a third remained olive-green for thirty days before becoming entirely pale brown. Only one of the brown mantids from Field No. 1 changed to green in the green cage, the other two remaining brown. In the latter case, however, only two to three days were spent in the coloured cages previous to ecdysis, which may account for the negative result (Table 3).

% Green
100.0
95.1
98.4

which
e of a
e, and
ed on
ainage
ound-
land.
dle of
there
ar the
m this
their
males
7. It
other
ception
own is
rgence
approx-
xually
to the

ground
%
28.0
26.8
fields
arriers

TABLE 3
Changes in the Coloration of Seventh Instar Mantids
in the Insectary

Exp. No.	Colour of cage lining	Nymph		No. days in cage before moulting	Colour 24 hours after moulting	Final Colour of Adult
		Origin	Colour			
-43	green	Field No.1	brown	2	brown	brown after 29 days
-37	"	"	"	3	pale	"
-38	"	"	"	11	" brown	brown after 70 days
-40	brown	"	"	3	green	green after 14 days
-32	"	"	"	11	brown	brown after 57 days
-27	"	Field No.2	green	16	"	brown after 61 days
-35	"	"	"	16	pale	"
-48	"	"	"	6	green	brown after 6 days
-46	"	"	"	23	olive	brown after 15 days
-42	"	"	"	8	"	brown after 9 days
-28	"	"	"	7	"	brown after 17 days
-47	"	"	"	4	pale	brown after 8 days
-34	"	"	"	8	"	brown after 30 days
					"	green after 13 days
					"	green after 63 days

Further tests were made last summer by exposing nymphs to actual plant backgrounds in the field. Rectangular cages of dimensions 9 x 9 x 12 inches, covered with coarse cotton, were used. One cage was placed over vigorous green grass nine inches in height, the other over a patch of short brown stubble and soil. The tests were begun on July 14, using third, and fourth instar nymphs. Three green ones collected from Field No. 2 were put into the cage enclosing the brown stubble, while the brown nymphs from Field No. 1 were placed in the green grass. For food, a daily ration of 15 crickets (*Nemobius* spp.) was fed to the nymphs. Care was taken to seal the bottom of the cages to prevent any escapes. In the course of the experiment two of the smaller nymphs were lost, most likely through cannibalism. Two of the brown nymphs became green in the fourth instar, while the same number of green individuals changed to brown in the sixth and adult instars respectively. After this had occurred, the four changed mantids were then transferred to cages covering vegetation similar to that of their original environment. As a result, one of the green mantids actually reverted to its original colour. No change occurred in the others, however, due partly to their advanced stage of development (Table 4). It was, therefore, apparent that the colour changes were not limited to pre-adult nymphs, but could also be induced in much earlier instars by altering the immediate environment of the insects.

TABLE 4
Colour changes of the Nymphs in Field Cages

Exp.	No.	Colour of plant cover	Instar	Origin	Colour	Colour after moulting	Interval
-27	(1)	green	III	Field No. 1	brown	green	6 days
	(2)	"	III	"	"	"	15 "
	(3)	"	III	"	"	brown	15 "
-28	(1)	brown	IV	" No. 2	green	"	8 "
	(2)	"	IV	"	"	"	28 "
	(3)	"	III	"	"	?	—
-36	(1)	"	IV	Exp. 27	"	brown ♀	26 "
	(2)	"	IV	"	"	green ♂	20 "
-37	(1)	green	VI	" 28	brown	brown ♀	23 "
	(2)	"	VIII	"	"	" ♀	30 "

All of the data considered seem to indicate that the colour of the mantids in the field is closely related to that of the plant cover. Whether the colour of the latter affects them directly, as it does certain other Orthoptera or indirectly through some other factor associated with the colour of the vegetation, is not altogether clear. While the experiments with the coloured boxes were not conclusive, they did show that colour changes in either direction and under the same conditions of temperature and humidity could occur. This would support the conclusion that the colour of the substratum and the quality of its reflected light are the factors which influence and determine the colour phases of the mantids.

REFERENCES

- Faure, J. C. The Phases of Locusts in South Africa. Bull. Ent. Research, 23:293-405, 1932.
 Hancock, J. L. Nature Sketches in Temperate America. A. C. McClurg & Co., Chicago, 1911.
 James, H. G. Observations on the Biology of *Mantis religiosa* L. Ann. Rep. Ent. Soc. Ont. 72, p. 45, (1941) 1942.
 Rabaud, E. Variation chromatique chez *Mantis religiosa*. Comptes rendus, Soc. Biol. Tome XCIV: 36-37, 1926.
 Wigglesworth, V. B. The Principles of Insect Physiology. Methuen & Co. Ltd., London, 1939.

THE OCCURRENCE OF TWO MALE FORMS, DICHOPTIC AND HOLOPTIC, IN *SIMULIUM EXIGUUM* ROUBAUD (DIPTERA, SIMULIIDAE)

BY ALFONS DAMPF,
Mexico City

Every student of entomology is familiar with the remarkable sexual dimorphism displayed by simuliid flies. There are not only striking differences in the coloration of the sexes, but also numerous morphological ones, as the different shape of the thorax, the different form of the claws, of the mouth organs, and especially of the eyes, which, dichoptic in the female, are holoptic in the male and are here sharply divided into an upper part with large facets and a lower strongly pigmented part with small ones. These eye peculiarities, present in all known simuliid species, with the one exception mentioned below, and perfectly well developed even in the single fossil male known, *Simulium oligocenicum* Rubtsov 1936 from the Baltic amber, constitute seemingly in the opinion of most dipterologists one of the chief characters of the family Simuliidae; at least Enderlein (1933, p. 273), in discussing the startling discovery of a simuliid fly with dichoptic eyes and uniform facets in both sexes (*Simulium feminineum* Edw. 1931) by the late F. W. Edwards in Southern Chile, declares that the new form deserves probably family rank and creates for it a new genus, *Archicnesia*, and a new subfamily, Cnesiinae.*

The present note will show that the simuliids have retained, at least in one species, in addition to the differentiated male form, which is holoptic and double-eyed, the archaic type of dichoptic male, and are thus unique among the dipterous families in possessing a case of very pronounced male dimorphism.

The material which led to the discovery of the dichoptic male form consists of a sample of specimens of *Simulium exiguum* Roubaud 1906, bred December 15, 1937, from pupae found in great numbers on submerged leaves of a fallen willow tree on the shores of the swift-running Rio Cajones in the north-eastern part of the state of Oaxaca, near the Veracruz border, altitude approximately 150 m., during field work in medical entomology with students of the "Escuela Nacional de Ciencias Biológicas" in Mexico City. The description of the pupa (respiratory organ with six branches) and of the larva and more morphological details about the adult fly will be given in a forthcoming publication on the onchocerca-transmitting simuliids of Mexico. In making drawings of the pupa, I was struck by the fact that some specimens, which according to the uniformly faceted eyes plainly visible through the pupal cuticula were females, had terminalia of the male type. In revising the whole lot of 171 adults, treated with caustic potash, I found 61 females, 14 holoptic males, and 96 specimens with eyes of the female type and with a less pronounced hump-back, but with male hypopygia of exactly the same type as in the holoptic males. The conclusion was inevitable that *S. exiguum* possesses two male forms, a holoptic and a dichoptic, the latter even more common than the so-called normal form. The suspicion arose that the same may occur in other simuliids and that Edwards, in describing his *Simulium (Gigantodax) feminineum*, based on 16 bred males and 4 bred females, had come across the same phenomenon, without realizing it for lack of typical males. Should this prove true, the new *Archicnesia* and the new subfamily Cnesiinae would become invalid.

* There is a confusing report about the eye conditions in the aberrant simuliid genus *Parasimulium* Malloch. The only known specimen of *Parasimulium furcatum* Malloch 1914, the genotype, is according to the original description a female with eyes widely separated. Knab (1914) calls the specimen a male and says that the male claspings organs are plainly visible. This would indicate that *Parasimulium* has dichoptic males. Dyar and Shannon, in their well known revision of the North American simuliids (1927), in redescribing the type, do not state the sex.

Simulium exiguum Roubaud, described from Venezuela, has been reported from Peru (Enderlein 1933) and Guatemala (Bequaert 1934). I have it also from Panama (L. W. Dunn coll., Camp Pital, Chiriqui province, Aug. 15, 1929, biting man), and there are specimens from Bolivia in the U. S. National Museum. It is a common species in Mexico, being found in the tropical parts of the states of Chiapas, Oaxaca, Michoacan, Veracruz and Tabasco and extending as far north on the Pacific Coast as to the state of Nayarit. The species is probably involved in the transmission of onchocerciasis, as I dissected from the thorax of one specimen eleven resting stages of a filariid of the *Onchocerca* type. This particular specimen was collected not far from Rancho Monter, Rio Cajones, Oaxaca, Dec. 17, 1937, near a place inhabited by some Indian onchocercacarrriers. *S. exiguum* bites man freely, but attacks also horses and mules, showing at some places preference for human (Oaxaca), at others for equine blood (Chiapas). Enderlein (1930, p. 85, 95) has made it the type of his new genus *Notolepria*, characterized by the short fifth metatarsal segment and the presence of scales on the thorax. *S. lutzi* Knab 1913 belongs to the same genus.

The female of *S. exiguum* is a very small, black simuliid, with the thorax irregularly covered by small patches of brilliant greenish or golden, elongate scales, arranged in groups up to 18 and interspersed with a few long, black, hair-like scales which are always single. The legs are honey-yellow, with the fore tarsi, mid and hind coxae, and hind tibiae and femora slightly infuscated. The clypeus, front, pleura, and the second abdominal tergite are silvery under certain angles of light. The last three or four abdominal tergites are shining black.

The holoptic or normal male has the thorax of the same colour as in the female, with the differences that the scales are more frequently of a golden hue, and that the posterior margin of the scutum is silvery or lead-coloured, but only in certain lights. The wings are strongly iridescent, with reddish reflections. The abdomen shows, besides the silvery second tergite, more or less extended silvery spots on the sixth and seventh tergites and sometimes also on segments 8 and 9. The hypopygium (fig. 1) belongs to the type with very short clasper or exopodite (C1). The adminiculum or basal plate of the penis-pouch is of the flat type, the rounded posterior margin being slightly prolonged. The anterior apodems or arms (Ap) of the adminiculum are laterally flattened and, in side view, exceptionally broad. The penis-guard (P), or the sclerite lying in the ventral wall of the phallosome (Ph), is short and apically divided into two rounded plates. The complicated arm (A), as the prolongation of the very corrugated parameral plate (Pa) is generally called, terminates in several spines of which the longest protrudes obliquely outwards. In the retracted state of the phallosome, the arms are folded inwards and the spine is not visible. The insertion-line of the intersegmental membrane (I) between the valvae and the ninth sternite (St9) divides the coxopodites or basal pieces (Co) into an exoskeletal and an endoskeletal part of nearly equal size. The anal conus, composed of the tenth tergite (T10) and the tenth sternite (St10) with the cerci (C), occupies only a small space above the phallosome.

The dichoptic male is of smaller size, which is clearly shown by the following measurements (the figures in brackets give the number of measured specimens). Distance from anterior border of scutum to posterior limit of scutellum: Female: 0.72 – 0.88 mm. (3), mean 0.78 mm.; holoptic male: 0.71 – 0.86 mm. (6), mean 0.81 mm.; dichoptic male: 0.65 – 0.70 mm. (5), mean 0.67 mm. The thorax is not so strongly curved (fig. 5c) as in the holoptic form (5b). The eyes are as in the female, the facets of exactly the same size (compare figs. 2 and 4), but the face and front (fig. 6B) are much narrower as in the female (fig. 6A); the suture which separates the regions forms an acute angle, not an obtuse angle as in the other sex. The most remarkable difference is in the length of the antennae (fig. 4) which, despite the smaller size of the dichoptic male, surpasses the length of the antennae of the female (fig. 2) and of the

holoptic male (fig. 3) as shown by the following measurements: Female, 0.40 – 0.45 mm. (4), mean 0.43 mm.; holoptic male, 0.45 – 0.50 mm. (7), mean 0.49 mm.; dichoptic male, 0.51 – 0.55 mm. (6), mean 0.54 mm. In dried specimens the antennal tip is generally strongly curved, which permits easy separation of dichoptic males and females. The thorax and abdomen show the normal male colouring and the terminalia are identical with those of the holoptic form.

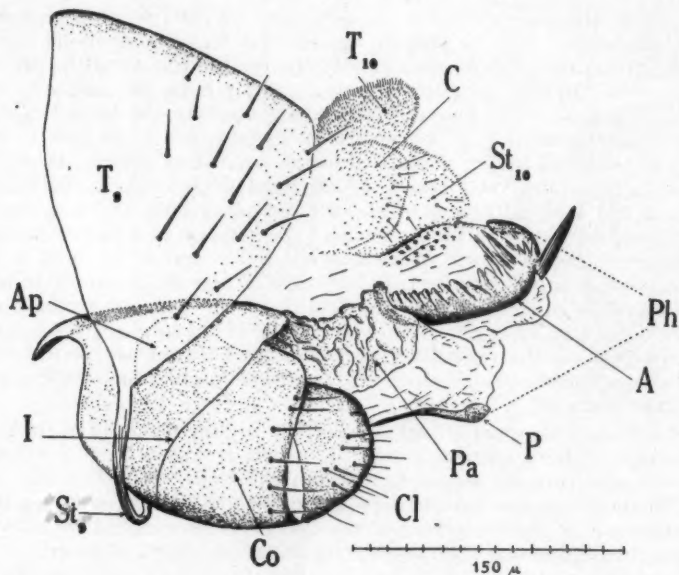


Fig. 1: Terminalia of male *Simulium* (*Notolepria*) *exiguum* Roubaud; side view, phallosome expanded.

- A – Curved arm of the parameral plate
- Ap – outline of the apodeme of adminiculum.
- C – cercus.
- Cl – clasper or distal part of the valvae.
- Co – coxopodite or basal part of the valvae.
- I – insertion-line of intersegmental membrane.
- Ph – phallosome.
- Pa – parameral plate.
- P – penis-guard.
- St₉ and St₁₀ – ninth and tenth abdominal sternites.
- T₉ and T₁₀ – ninth and tenth abdominal tergites.

The morphological similarity of the heads of the female and the dichoptic male leads immediately to the question: Are these males able to bite? Dissection of the mouth parts showed that they are of the normal male type, and that they cannot pierce human skin.

That these males behave nevertheless somewhat differently is proven by an observation made November 27, 1933, near Guatemala City (Guatemala), where I captured near a small brook six specimens of *Simulium exiguum* flying around my face without making attempts to bite. The specimens proved to be four females and two dichoptic males. Among many thousands of simuliid flies captured on or around human beings and domestic animals, I have never seen a holoptic male with the exception of specimens which casually enter rooms and

accumulate on the window panes. The behaviour of the Guatemalan specimens is therefore quite exceptional and would perhaps indicate that the dichoptic males of *S. exiguum* are attracted by the body odour or heat emanations of man as the males of *Culex fatigans* Wied. are attracted.† A sample of 522 specimens of *S. exiguum*, captured February 29, 1932, while attacking us near Yagalaxi, an Indian village in the state of Oaxaca, east of Rio Cajones, was composed exclusively of females.

There are unfortunately no observations on the courtship customs of the second male type. We can perhaps assume that on account of the reduced eye sight the dichoptic males have suppressed dancing in the air, so common among nematocerous Diptera, as a means of attracting females, and rely more on olfactory reactions. The better developed antennae would in this case serve as compensation for the loss of eye power. It would be a futile task to speculate about the genetical causes of male dimorphism in *S. exiguum*, about holoptic and dichoptic strains, and about the external factors which determine their numerical relations, as there is little possibility of making breeding experiments owing to technical difficulties in rearing. We have no idea about the biological significance of the two male forms and can only express the opinion that the dichotomic male represents the primitive type of this sex in simuliids, apparently suppressed in other species of the family by the holoptic form, but which has not disappeared in *S. exiguum*. It would be wrong to speak of a gynaeomorph male type, as the masculine characters are quite normal in the dichoptic form and the apparent similarity with the female is only due to the presence of generalized features.

Polymorphism among insects, especially in ants where cases of dimorphic males occur (*Ponera eduardi* Forel), is generally ascribed to a physiological division of labor among originally similar individuals (Wheeler, *Ants*, p. 118). It is difficult to conceive how this explanation could be used in the present case. Any difference in the behaviour of the two types of simuliid males would be the consequence and not the cause of the morphological difference.

In revising the accessible entomological literature, I found only the following two records of dimorphism of the same sex relative to eye differences*: According to Berlese (1925, p. 426), who quotes Peyerimhoff, the staphylinid beetle *Pachycorinus dimorphus* from New Zealand has two female forms, one with normal eyes and the other nearly blind, with only a few facets. Berlese does not mention Fritz Müller's two famous papers (1879 and 1881), in which this exceptionally gifted observer gives descriptions and drawings of the two female forms of the Brazilian blepharocerid fly *Curupira* (*Paltostoma*) *torrentium*, one with normal dichoptic eyes and with well developed mouth parts of the bloodsucking type, the other with eyes much smaller, only half the size, and with reduced mouth parts of the male type adapted for sucking nectar. The male is holoptic in the genus *Curupira* and double-eyed, as in simuliids. Both female forms in *Curupira*, according to F. Müller, show differently formed claws, the other morphological details remaining the same. Meisenheimer (1921, p. 733) quotes Kellogg (*Zool. Anz.*, Bd. 21, 1898), according to whom the North American *Blepharocera capitata* presents the same two female forms as the

† E. Corti (*Atti Soc. Ital. Sci. Nat.*, LIV, 1916, p. 229) states that males of *Simulium lineatum* Meig. can be found in Italy, together with the females, in the ears of domestic animals and that the males molest man by crawling over the face as if attempting to bite. This would indicate a behaviour quite different from the normal.

* I have found more recently Z. Szilady's paper, "Dimorphe Maennchen und archaische Formen bei Dipteren" (5e Congr. int. Ent., Paris, (2) pp. 239-242, 1932). This author notes that in the dipterous families Therevidae and Rhagionidae there are several "species" known only from dichoptic males. He suggests that these may belong to species known from females and holoptic males, "a phenomenon," he adds, "thus far not known among insects." The discovery of male dimorphism in simuliids adds weight to this assumption.

Brazilian species, but as Kellogg in his monograph (1903, p. 208), and also in treating the family in Williston's *Manual of North American Diptera* (third edition, 1908, pp. 148-152), fails to mention any female dimorphism, the first note was based probably on an error of identification. F. Müller's report was put in doubt by A. Lutz in two papers (Mem. do Inst. Oswaldo Cruz, Vol. 12, 1920, and "Estudios", 1928, p. 66), who claims that the observations were based not on one species but on two genera and four species and that there is consequently no dimorphism at all. In spite of this statement, Comstock (*An Introduction to Entomology*, 8th edition, 1936, p. 826) mentions the existence of two female types in blepharocerids, "in some species at least," without giving

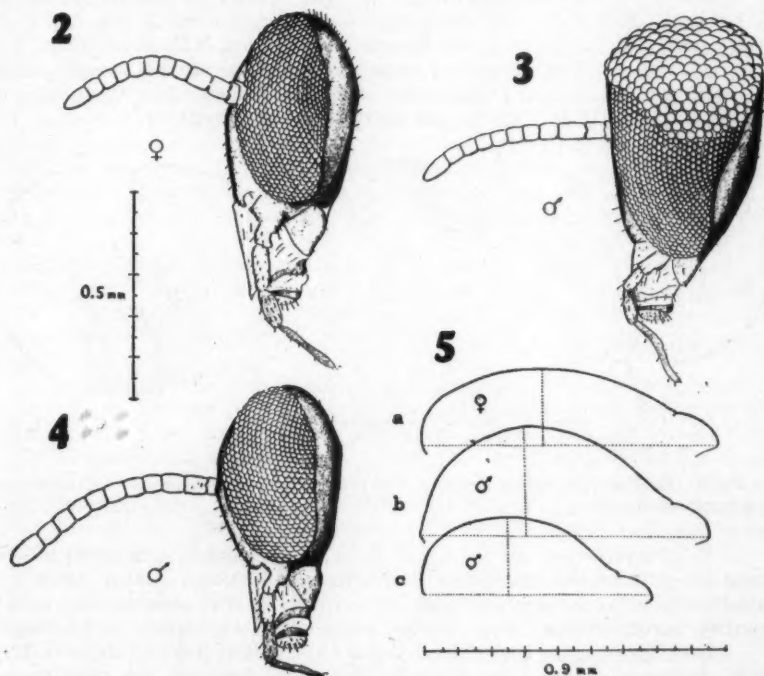


Fig. 2: *Simulium (Notolepria) exiguum* Roub.; head of the female, side view. Fig. 3: Same, holoptic male. Fig. 4: Same, dichoptic male. Fig. 5: Outline of thorax and scutellum of *S. exiguum*, side view. a - female, b - holoptic male, c - dichoptic male.

more details. Shiro Kitakami, in his monograph of the Blepharoceridae of Japan (Kyoto, 1931), has no data about female dimorphism in this family.

It seems therefore that the case reported in the present paper, the occurrence of two male forms in *Simulium exiguum*, one holoptic and one dichoptic, remains unique among Diptera and perhaps among insects.

Dimorphism in males has been reported in various groups of animals, chiefly in arthropods, but it is not always clear if this so-called dimorphism consists in fluctuating variability with two maxima, as in *Forficula auricularia* L., or if two genetically fixed forms are present, as in our case. The following list is far from complete, but gives at least an idea about this very little known biological phenomenon.

(1) In Coleoptera we have, in the African cerambycid beetle *Acanthophorus confinis* Lameere, one male form with long antennae and short man-

dibles and the other with long mandibles and short antennae (Hesse and Doflein, p. 496). In the staphylinid *Bledius taurus*, part of the males have a long cephalic horn and a short thoracic one, and in the other part the characters are reversed.

(2) In the agaonid wasps of the superfamily Chalcidoidea, male dimorphism is apparently of common occurrence. Berlese (p. 423) figures a striking case of dimorphic apterous males in *Pleistodontes imperialis* from Australia, and Grandi (Boll. Labor. Entom. R. Inst. Sup. Agrario, Bologna, 1928, Vol. I, pp. 203-210) describes in detail the winged and apterous males of *Crossogaster triformis*. Other cases of male dimorphism in chalcidid fig parasites (*Heterandrium*, *Aepocerus*, etc.) were discovered by Fritz Müller in Brazil (Trans. Ent. Soc. London, 1886, Proc. p. X-XII; Biol. Centralblatt, 1886/7, Bd. VI, p. 120; Kosmos, 1886, Bd. XVIII, p. 55-62; Entom. Nachr., 1886, XII, p. 193-199).

(3) A. da Costa Lima has recently reported a case of "atelic poecilandry", as he calls it, in the hymenopterous family Scelionidae (Agronomia, Rio de Janeiro, I, pp. 113-115, 1942), but I have not seen the paper.

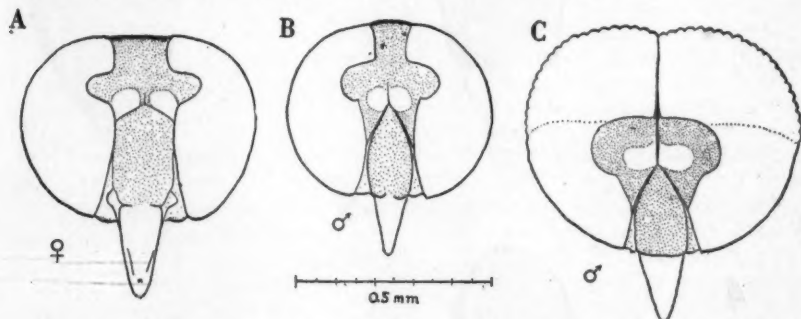


Fig. 6: Head of *Simulium exiguum* Roub., front view. A — female, B — dichoptic male, C — holoptic male.

(4) Various cases are known of short winged and long winged, of apterous and winged males in Plecoptera, Embioptera, aphids and coccids, but it is not always clear how far fluctuating variability is involved. The same kind of wing dimorphism, involving both sexes, is not infrequent in Hemiptera or Orthoptera.

(5) According to L. O. Howard and C. V. Riley (Insect Life, Vol. V, pp. 189-194, 1893), the water bug *Rheumatobes rileyi* Bergroth has two forms of males: One normal and the other with characteristically enlarged and spinose antennae and swollen and curved hind thighs. The authors indicate that there is considerable variation and that intermediate forms are present.

(6) A second male type with enlarged posterior legs is also known in the parasitic acarid *Analgas clavipes*; another acarid, *Bdellorhynchus polymorphus*, has a second male form with enormously enlarged anterior legs (Meisenheimer, p. 698). The same author cites male dimorphism in spiders (*Linyphia montana* and *Tarentula barbipes*), involving mouth parts and legs.

(7) K. Verhoeff discovered male dimorphism and even trimorphism in diplopods (Zeitschr. wiss. Zool., Bd., 116, 1916) and considers it in relation with climatic factors.

(8) Numerous cases of male dimorphism are reported in Crustacea, e.g., in *Pontoporeia affinis* (males with long and short antennae); in *Leptocheila dubia* (cheliceræ in one male form greatly enlarged); others in Amphipoda, Decapoda, etc.

French, Italian, Spanish and Brazilian authors are accustomed to classify all these cases under "poecilandry," which is a synonym of male polymorphism.

As male dimorphism in its strictest sense, shown in *Simulium exiguum* and perhaps in a few other cases enumerated above, has a quite different genetic basis and is comparable to caste formation in social insects (a collective phenomenon), the term poecilandy cannot be used here, as it indicates something variable (like poecilothermic, which means "with variable blood temperature"). Heterandry would be perhaps a suitable word; diandry would be even better as it conveys the idea of two male forms, but would lead to confusion, as monandry and polyandry are used in relation to the sexual behaviour of the female, and diandry could be interpreted in the same sense. "Diandric and digynaic species" would be a safe expression to designate such species which have chosen for one of its sexes two lines of evolution.

There are in the literature conflicting views about the function of the peculiar holoptic double eyes in the males of insects, of which ephemerids and simuliids present such remarkable examples. Comstock (1936, p. 822), speaking of simuliids, says that the upper part is "doubtless a night-eye, while the lower half is a day-eye." This supposition, which goes back to Chun and Zimmer, seems morphologically well founded, but the biological data do not fit, as the simuliids are day-flying insects. The simultaneous occurrence of micro- and macromattidia in the compound eyes of dipterous males has been recorded, according to Hendel and others, for the following families: Acroceridae, Bombyliidae, Tabanidae (genera *Atylotus* Rond., *Straba* End., *Sipala* End., *Ommalia* End.), Stratiomyidae, Scenopinidae and Bibionidae. Both sexes possess the same morphological peculiarity in most Blepharoceridae and in some Empididae, Leptidae, Therevidae and Asilidae, all families with predaceous habits. Nearly all these Diptera are day-flying insects, which is a strong argument against the night and day-eye hypothesis.

The most probable explanation of the function of the double eye, at least in Diptera, assumes that the upper part, with larger facets, serves for long distance and the lower part, with smaller facets, for near distance vision. Enderlein (1931) has called attention to the fact that the lower part of the double eye in the tabanid *Ommalia herculeana* is much more pigmented (the same occurs in simuliid males), insuring in this way a better utilization of the faint light from nearer objects. He compares the double eye in insects with the human invention of bifocal eye-glasses.

In following a sympathetic Latin American custom, I dedicate this contribution to the memory of Eric Hearle, the late Assistant Entomologist of the Entomological Laboratory in Kamloops, British Columbia, whose successful work on Canadian simuliids was interrupted by his early and unexpected death.

Females and both types of males of *S. exiguum* will be deposited in the collections of the following institutions: The Canadian Department of Agriculture, Ottawa; the U. S. National Museum, Washington; Massachusetts State College, Amherst; Cornell University, Ithaca; the Leland Ossian Howard Laboratory of the School of Biological Sciences, Mexico City; the Instituto de Salubridad y Enfermedades Tropicales, Mexico City; the Instituto Oswaldo Cruz, Rio de Janeiro; the British Museum (Natural History); and the Zoologisches Museum, Berlin.

SUMMARY

During taxonomic work on onchocerca-transmitting simuliid flies of Mexico, the author discovered in *Simulium (Notolepria) exiguum* Roubaud the existence of two male forms, a holoptic and a dichoptic, the latter with longer antennae, apparently a compensation for reduced vision. The term "diandric species" is proposed for species with two male forms. The current interpretation, that the upper part of the double eye of the holoptic simuliid male is a night-eye and the lower part a day-eye, seems not well founded, as all insects with such a special eye form are day-flying in habit.

BIBLIOGRAPHY

- Berlese, A. 1925. Gli Insetti, Vol. II; Milano, IX & 992 pgs., 895 figs., 7 plates.
- Edwards, F. W. 1931. Simuliidae, in *Diptera of Patagonia and South Chili*. Part II, fasc. 4, pp. 121-154, fig. 7-13. London, British Museum.
- Enderlein, G. 1931. Parallelismus der Erfahrungen in der belebten Natur. Entom. Jahrbuch, Leipzig, Reprint, 3 pgs., 1 plate.
- Enderlein, G. 1931. Der heutige Stand der Klassifikation der Simuliiden. Archiv klassifik. Entom. 1, 2, Wien, pp. 77-97.
- Enderlein, G. 1933. Weiter Ausbau des Systems der Simuliiden. Deutsche Entom. Zeitschr. H. 2/3, pp. 273-292.
- Hendel, Fr. 1936. *Diptera*, in *Handbuch der Zoologie*, Bd. IV, T. 2, pp. 1729-1998, figs. 1855-2173, Berlin & Leipzig.
- Hesse, R. & F. Doflein. 1910. Tierbau und Tierleben. I Band, Leipzig & Berlin, XVII & 789 pgs., 480 figs., 15 plates.
- Kellogg, Vernon L. 1903. The net-winged midges (Blepharoceridae) of North America. Proc. Calif. Acad. Sci., 3d ser., Zoology, Vol. III, pp. 187-232, plates 18-22.
- Lutz, A. 1928. Estudios de Zoologia y Parasitologia Venezolanas. Rio de Janeiro, Dic. 1928, 130 pgs., 26 plates.
- Meisenheimer, J. 1921. Geschlecht und Geschlechter im Tierreiche. I Bd., Jena, Gustav Fischer, XIX & 896 pages., 737 figs.
- Müller, Fritz. 1879. A metamorphose de um insecto diptero (*Paltostoma torrentium*). Primeira Parte. Descripcão do exterior da larva (Archiv. do Mus. Nacional do Rio de Janeiro, Vol. IV, pp. 47-56, est. IV). Segunda y terceira Parte. Anatomia de larva (ibid. pp. 57-63, est. V, pp. 67-74, est. VI). Quarta Parte. Chrysalida e insecto perfecto (ibid. pp. 75-85, est. VII). (Reprinted in: Fritz Müller, Werke, Briefe und Leben. I Bd., Jena, Gustav Fischer, 1915, pp. 801-831, Taf. 58-61. Translated into German, pp. 1470-1504).
- Müller, Fritz. 1881. *Paltostoma torrentium*. Eine Mücke mit zwiegestaltigen Weibchen. Kosmos, 1880/81, Bd. VIII, S. 37-42, 11 figs. (Reprinted in Werke, Briefe und Leben, Bd. I, pp. 844-849). (See also: H. Müller: Explanation of the female dimorphism of *Paltostoma torrentium*. Nature, 1881, p. 214).
- Rubtsov, I. A. 1936. A new species of a simuliid fly (*Simulium oligocenicum* sp. n.) from amber. Doklady Akademii Nauk SSSR, Vol. II (XI), No. 8 (94), pp. 347-349, 1 fig. (in Russian).

NEW DESCRIPTIONS OF LARVAE OF FOREST INSECTS, VIII.
LARVAE OF THE GENUS *MELANOLOPHIA* (LEPIDOPTERA,
GEOMETRIDAE)*

BY W. C. MCGUFFIN,

Ottawa, Ontario

The insects of the genus *Melanolophia* are forest insects in Canada, the larvae feeding on both coniferous and deciduous trees. McDunnough, in his bulletin (2) discusses five species, three of which are found in Canada.

The larva of *M. imitata* Walk., a species confined to British Columbia, has been described by Dyar (1) and that of *M. canadaria* Gn. has been described by McDunnough (3). Both this latter species and the one to be described in this paper, *M. signataria* Wlk., are distributed over Eastern Canada. Additional notes are given on the previously described species and a key for the separation of mature larvae is placed at the end of this article.

The illustrations have been done by Miss M. R. MacKay to whom the author wishes to express his sincere appreciation.

***Melanolophia signataria* Wlk.**

Fig. 1

Ultimate Instar: Width of head 2.2 to 2.5 mm. Body 18 to 23 mm. in length and 1.9 to 2.5 mm. in width. Integument smooth. Ground colour of body yellow green; middorsal line consisting of a fine, green single stripe run-

*Contribution No. 2212 from the Division of Entomology, Science Service, Department of Agriculture, Ottawa.

ning from thoracic segment 1 to abdominal segment 1 inclusive. This line becomes double on abdominal segments 2 to 6 and encloses elongate yellow green dashes (one to each segment) interrupted at the segmental incisures by a fusion of the darker green colour; addorsal line light green; subdorsal line fine, yellow green; supraspiracular area ground colour with fine, white broken lines; in living specimens the spiracular line appears as a yellow-green fold. (There may be a pink suffusion in this line on the first abdominal segment). Venter green with very faint lines; body conspicuously yellow at intersegments. Head slightly rugose, light green in colour with either white marbling or a small dark patch near tip of adfrontals. Adfrontals and frons light green; epicranial index 1.0 to 1.3. Postclypeus light green; preclypeus dirty white. Labrum light brown with a notch the depth of which is less than half the width of the labrum. Distance between ocelli 1 and 2 from 1 to $1\frac{1}{2}$ times that between ocelli 2 and 3. Prothoracic shield green with white subdorsal line crossing it; anal shield green, yellowish at lateral edges and smoothly rounded at posterior end. Setigerous tubercles consisting of light brown papillae set directly on the integument; setae moderately long and conspicuous. Spiracles brown with yellow centres. Thoracic legs light green with brownish tips; prolegs green, sometimes pink distally. Each ventral proleg bears 20 to 26 crochets.

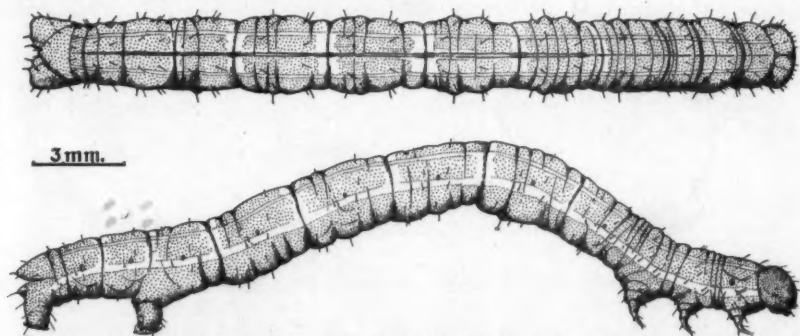


Fig. 1. Larva of *Melanolophia signataria* Wlk.

Mouthparts: Mandibles (fig. 2, b) light brown with two prominent ridges and eight, or occasionally nine, teeth, most of the teeth well rounded off on biting edge. Hypopharynx conical, lingua tomentose, remainder smooth; spinneret subcylindrical, rounded at tip. Labial palpi with the segments in the proportion of 10, 2 and 9.

Food Plants: Balsam, white spruce, tamarack and yellow birch.

***Melanolophia canadaria* Gn.**

Ultimate Instar: Width of head 2.3 mm. Body 30 to 35 mm. in length and 2.5 mm. in width. Ground colour yellow-green; middorsal line of light ellipses on abdominal segments 2 to 6, enclosing ground colour. Addorsal and subdorsal lines fine, light; in supraspiracular area are two fine, light lines. The yellow spiracular line may be suffused in whole or in part with red. Ventral area green. Head yellow-green or greenish, rugose. Epicranial index 1.0 to 1.5. Distance between ocelli 1 and 2 equal to that between ocelli 2 and 3. Prothoracic shield green; anal shield green with yellow at edges. Setae long. Thoracic legs and prolegs yellow green, the ventral proleg bears 24 or 25 crochets.

Mouthparts: Mandibles (fig. 2, a) light brown with two prominent ridges and eight or nine teeth. Hypopharynx conical, lingua tomentose; remainder of hypopharynx smooth. Spinneret subcylindrical, rounded at tip; labial palpi with segments in proportion of 11:3:9.

Food Plant: Balsam, red maple, staghorn sumac, rock elm, white and yellow birch.

***Melanolophia imitata* Wlk.**

Penultimate Instar: Head width 1.5 to 1.9 mm. Body about 20 mm. in length and 2.2 mm. in width. Epicranial index 0.9 to 1.3. Distance between ocelli 1 and 2 equal to $1\frac{1}{2}$ times that between ocelli 2 and 3. Crochets on ventral proleg number 12.

Ultimate Instar: Head width 2.4 to 2.6 mm. Body about 25 mm. in length and 2.5 to 2.6 mm. in width. Epicranial index 0.9. Distance between ocelli 1 and 2 equal to that between ocelli 2 and 3. Crochets on ventral proleg number 30.

Mouthparts: Mandibles (fig. 2, c) light brown with two well defined ridges and a trace of a third. The nine teeth are more acute than those of the other two species. Hypopharynx conical; lingua with a few scattered hairs on

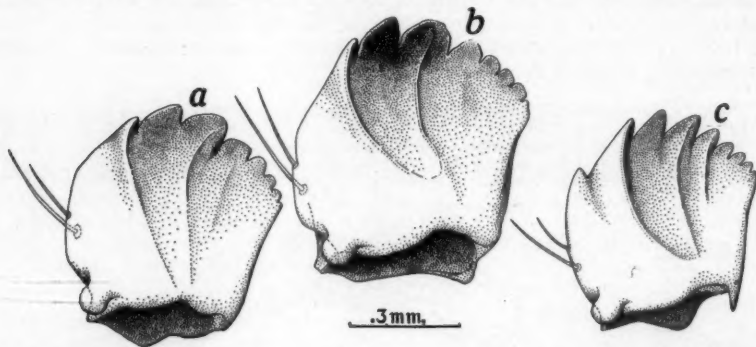


Fig. 2. Mandibles of (a) *Melanolophia canadaria* Gn., (b) *M. signataria* Wlk., and (c) *M. imitata* Wlk.

it, remainder smooth. Spinneret subcylindrical rounded at tip. Labial palpi with segments in proportion of 10, 2 or 2.5, and 10.

Food Plants: Engelmann and Sitka spruce; Douglas fir.

KEY TO THE LARVAE OF THE CANADIAN SPECIES OF MELANOLOPHIA.

1. Larvae with dorsal lines white; never with pink in spiracular line. Head with no dark colour; teeth of mandibles fairly acute (fig. c). Found only in British Columbia. *imitata*

Larvae with dorsal lines yellowish; often with some red in spiracular line. Head may have dark spots; teeth of mandibles quite blunt. Found only in Eastern Canada. *canadaria*

2. Spiracular line partially or completely red; head clear green; large tooth of mandible rounded, much inclined; other teeth rounded and separated (fig. a). *canadaria*

Spiracular line red on first abdominal segment only, or not at all; head often with two dark markings; large tooth of mandible truncate, more inclined than other teeth; other teeth truncate and close together (fig. b). *signataria*

REFERENCES

1. Dyar, H. G. (1905) Life histories of North American Geometridae. *Psyche* 12:58-59.
2. McDunnough, J. H. (1920) Studies in North American Cleorini. *Tech. Bull. No. 18*, Dept. of Agriculture, Ottawa, Canada. pp. 12-14, illust.
3. McDunnough, J. H. (1933) Notes on early stages of certain noctuid and geometrid species. *Can. Ent.* 65:123.

MALLOPHAGA OF ALBERTA: A LIST OF SPECIES WITH HOSTS

BY J. H. BROWN AND A. L. WILK,

University of Alberta, Edmonton

Very little attention has been paid to the occurrence of Mallophaga in western Canada, particularly in Alberta. The reason for this is two-fold. First, the difficulty of obtaining keys to species and, second, the extreme difficulty of collecting specimens. This paper reports the occurrence of thirty-eight species in the province.

All of the species, with the exception of one, reported in the present paper were collected by Mr. A. L. Wilk during a period extending from April, 1941, to early in 1942, while collecting ornithological and mammalogical material for various museums. A total of 250 birds and mammals, representing over sixty species, were examined. Of these, more than half carried Mallophaga. Most of the material was collected during the summer months, and it is a point of interest that few Mallophaga were present on the birds and mammals taken during July.

It was found that host lists, though helpful, were not wholly reliable for species determination. In some instances it was found that a bird with a wide distribution carried several species of Mallophaga, the species varying with the geographical distribution of the host. In other instances several species of Mallophaga, listed as from different birds, were taken from a single host. This suggests that these ectoparasites are frequently exchanged by association.

Various methods for the preparation of study slides were tried and the one chosen is outlined below. This method was suggested by Dr. R. B. Millar of the Department of Zoology.

1. Place the specimen in 10% KOH and leave overnight.
2. Heat the KOH until it simmers. Keep hot for about three minutes but do not boil. (This step may be omitted for all but the most difficult specimens.)
3. Wash in tap-water for not less than one-half hour, changing the water at least once.
4. Place specimen in glacial acetic acid for three minutes.
5. Transfer to glacial acetic acid to which a few drops of 5% aqueous acid fuchsin have been added (approximately four parts acetic to one part stain). Leave for three minutes.
6. Transfer to clear glacial acetic acid to remove excess stain. Leave for one minute.
7. Clear in clove oil for about three minutes.
8. Mount in Clarite.

This method was very simple and allowed for rapid handling of the specimens.

We wish to express our appreciation for assistance received from E. W. Stafford of Mississippi State College in making some determinations and in verifying others. We wish also to extend our thanks to Robert Lister, technician of the Department of Zoology, University of Alberta, for advice and assistance in the preparation of slides.

LIST OF SPECIES WITH HOSTS

Family Menoponidae

1. *Actornithophilus spinulosus minimus* Kellogg & Chapman. Host: Downy Woodpecker.
2. *Actornithophilus timidus* Kellogg. Host: Wilson's Phalarope.
3. *Actornithophilus uniformis* Kellogg. Host: Avocet.
4. *Austromenopon aegialitidis* Durrant. Host: Solitary Sandpiper.
5. *Colpocephalum flavescens* Nitzsch. Host: American Sparrow Hawk.
6. *Colpocephalum* sp. Host: Pigeon Hawk.
7. *Menacanthus* sp. Host: House Wren.
8. *Menopon stramineum* Nitzsch. Host: Chicken.
9. *Myrsidea eurysterna* Nitzsch. Host: Magpie.
10. *Trinoton querquedulae* Linnaeus. Host: Mallard.

Family Ricinidae

11. *Ricinus diffusus* Kellogg. Host: Savannah Sparrow, Song Sparrow.

Family Trichodectidae

12. *Geomydæcus thomomys* McGregor. Host: Pocket Gopher.
 13. *Trichodectes scalaris* Nitzsch*. Host: Domestic Cattle.

Family Philopteridae

14. *Anatoecus dentatus* Scopoli. Host: Mallard.
 15. *Brüelia angustifrons* Carr. Host: Clay-colored Sparrow.
 16. *Brüelia rotundata* Osborn. Host: American Crow.
 17. *Brüelia vulgata* Kellogg. Host: House Wren, Tree Sparrow.
 18. *Columbicola columbae* Linnaeus. Host: Pigeon.
 19. *Carduiceps complexiva* Kellogg & Chapman. Host: Dowitcher, Baird Sandpiper.
 20. *Degeeriella fusca* Nitzsch. Host: Pigeon Hawk, Red-tailed Hawk.
 21. *Esthiopterum crassicornis* Scopoli. Host: American Widgeon.
 22. *Eustrigiphilus ceblebrachys* Nitzsch. Host: Snowy Owl.
 23. *Gonicotes bidentatus* Scopoli. Host: Pigeon.
 24. *Gonoides meleagridis* Linnaeus. Host: Turkey.
 25. *Lipeurus heterographus* Nitzsch. Host: Pheasant Chick.
 26. *Lipeurus variabilis* Nitzsch. Host: Chicken.
 27. *Penenirmus californiensis* Kellogg. Host: Yellow-bellied Sapsucker, Palm Warbler.
 28. *Penenirmus jungens* Kellogg. Host: Yellow-shafted Flicker.
 29. *Penenirmus* sp. Host: Downy Woodpecker.
 30. *Philopterus agelai* Osborn. Host: Red-winged Blackbird.
 31. *Philopterus corvi* Linnaeus. Host: American Crow.
 32. *Philopterus picae* Denny. Host: Magpie.
 33. *Philopterus subflavescens* Geoffrey. Host: Common Shrike, Northern Shrike, Savannah Sparrow, Rock Wren, House Wren, Horned Lark, Pine Grosbeak.
 34. *Quadriceps interrupta* Piaget. Host: Solitary Sandpiper.
 35. *Quadriceps rava* Kellogg. Host: Dowitcher.
 36. *Quadriceps signata* Piaget. Host: Avocet.
 37. *Quadriceps testudinarius* Childrien. Host: Avocet.
 38. *Sæmundssonina* sp. Host: Mallard (Probably from Plover).

LIST OF HOSTS WITH SPECIES

The numbers following the host name refer to the species index.

Avocet (<i>Recurvirostra americana</i>)	3, 36, 37
American Crow (<i>Corvus brachyrhynchos</i>)	16, 31.
American Sparrow Hawk (<i>Falco sparverius</i>)	5.
American Widgeon (<i>Mareca americana</i>)	21.
Baird Sandpiper (<i>Pisobia bairdi</i>)	19.
Chicken (<i>Gallus domesticus</i>)	8, 26.
Clay-colored Sparrow (<i>Spizella pallida</i>)	15.
Common Shrike (<i>Lanius ludovicianus</i>)	33.
Domestic Cattle (<i>Bos taurus</i>)	13.
Dowitcher (<i>Limnodromus griseus</i>)	1, 19, 35.
Downy Woodpecker (<i>Dryobates pubescens</i>)	29.
Horned Lark (<i>Otocoris alpestris</i>)	33.
House Wren (<i>Troglodytes aedon</i>)	7, 17, 33
Magpie (<i>Pica pica</i>)	9, 32.
Mallard (<i>Anas platyrhynchos</i>)	10, 14, 38.

*Reported by Strickland.

row.

Baird

k.

cker,

thern
ark,

37
31.
5.
21.
19.
26.
15.
33.
13.
35.
29.
33.
33
32.
38.

Northern Shrike (<i>Lanius borealis</i>)	33.
Palm Warbler (<i>Dendroica palmarum</i>)	27.
Pheasant Chick (<i>Phasianus spp.</i>)	25.
Pigeon Hawk (<i>Falco columbarius</i>)	6, 20.
Pigeon (<i>Columba livia</i>)	18, 23.
Pine Grosbeak (<i>Pinicola enucleator</i>)	33.
Pocket Gopher (<i>Thomomys spp.</i>)	12.
Red-tailed Hawk (<i>Buteo borealis</i>)	20.
Red-winged Blackbird (<i>Agelaius phoeniceus</i>)	30.
Rock Wren (<i>Salpinctes obsoletus</i>)	33.
Savannah Sparrow (<i>Passerculus princeps</i>)	11, 33.
Snowy Owl (<i>Nyctea nyctea</i>)	22.
Song Sparrow (<i>Melospinza melodia</i>)	11.
Solitary Sandpiper (<i>Tringa solitaria</i>)	4, 31.
Tree Sparrow (<i>Spizella arborea</i>)	17.
Turkey (<i>Meleagris gallopavo</i>)	24.
Wilson's Phalarope (<i>Steganopus tricolor</i>)	2.
Yellow-bellied Sapsucker (<i>Sphyrapicus varius</i>)	27.
Yellow-shafted Flicker (<i>Colaptes auratus</i>)	28.

THE USE OF OLD POLISTES NESTS BY ODYNERUS FORMININATUS AND ANCISTOCERUS FULVIPES FOR NESTING PURPOSES.

The discarded paper nests of *Polistes* wasps make excellent nesting places for other species of aculeate Hymenoptera, especially for those species that work in mud. I have already published accounts of such use of the nests by the wasp, *Trypoxylon clavatum* and the bee, *Osmia lignaria*.^{*} Both of these species clean out old *Polistes* cells and use them for their own young. With mud they partition the cell into small rooms, provide each with food and an egg, and finally seal the opening with a plug of mud.

The two above mentioned eumenid species behave similarly. From an old nest of *Polistes pallipes* taken at Ranken, Missouri, I bred three males of *Ancistrocerus* (*Parancistrocerus*) *fulvipes* de Sauss. [G. A. Sandhouse] on June 9 and 10, 1934, and likewise on a few occasions I have bred *Odynerus foraminatus* from similar mud-plugged nests. I can give some details of nest making by one mother of the latter species.

A female *O. forminatus* was observed at Kirkwood while she was bringing in caterpillars on May 27, 1934; she made and stocked more than one cell a day, for at the end of the week she had completed ten cells. Using mud for partitions she made two or three cells in each of the wasps' cells. Into each of these cells she put caterpillars and an egg, and on the whole, completing ten such units in seven days shows a good deal of industry. Each night the mother slept in one of the incomplected cells. The immature stages of *O. forminatus* are short; eggs deposited between May 27 and June 2 hatched, became larvae, pupated, and emerged as adults June 20 to June 26, a period of three to four weeks for the complete development from hatching to adult.

Before this nest was taken indoors, two species of ants, *Camponotus fallax discipiens* Em. [Mann], and *Solenopsis molesta* Say [M. R. Smith], had entered the nest and destroyed some of the young.

Phil Rau, Kirkwood, Mo.

^{*}Field studies of non-social wasps. Trans. Acad. Sci. St. Louis, 25:322-489, 1928.

ECONOMIC IMPORTANCE AND HOST RELATIONSHIP OF
PELECINUS POLYTURATOR DRURY

BY G. H. HAMMOND,

Ottawa, Ontario

The odd-appearing female of *Pelecinus polyturator* Dru. is a moderately common insect, generally recognized as a parasite of *Phyllophaga* larvae. However, few references in literature substantiate the host relationship or furnish evidence to associate parasite with host. Dr. S. A. Forbes (1) reared *Pelecinus* from a white grub, in Illinois during 1892, but apart from references to the occurrence of the adult female at a number of points in the northern United States and southern Canada, there were evidently no definite records of actual parasitism of common white grubs until 1925.

Petch and Hammond (2) in that year gave an account of the parasites of *Phyllophaga* in southern Quebec and mentioned the finding of a single *Pelecinus* pupa in close contact with the shrivelled skin of the white grub host. Since that time, additional specimens of *Pelecinus* have been reared and further observations made on white grubs retained in individual rearing tins at Hemmingford, Clarenceville and Oka in Quebec, also at Spencerville and Marmora in Ontario. The whitish, elongate, parasitic larva emerges from the white grub host through an elongate slit extending along the mid-ventral line of the body. After emergence the larva remains quiescent for a period of three days, and at the termination of this period the pupal envelope is formed. Shortly afterward the prepupa can be observed through the envelope. The latter is light brown, loose, semitransparent, and development of prepupa and pupa can be observed through it without difficulty. In the field, the pupa is formed at a depth of about four inches in the soil, usually in the cavity formerly occupied by the host.

The full life-history has not yet been established, but it is believed to be of one-year duration, with the *Pelecinus* larva typically emerging from third year white grubs. Emergence from white grubs occurs in most years between July 13 and 20, with adult emergence occurring between July 29 and August 25, and the combined prepupal and pupal periods averaging 30 days. In 1929 eleven adults were reared from parasitized white grubs.

Although the parasitism by *Pelecinus* is typically less than one per cent, this may rise to nearly three per cent, as in the case of material taken from Oka, P. Q., in 1929. In comparison with *Tiphia* and *Microphthalma* it is definitely a minor parasite of *Phyllophaga* larvae; nevertheless, on account of the numbers of adult females observed on the wing at intervals, one is led to believe that this widespread parasite destroys important numbers of white grubs.

Because adults of *Pelecinus* are often found in numbers over forested or scrubby land at a considerable distance from open pastures or meadows where white grubs would be found in maximum concentrations, many entomologists believe that the parasite may have an alternate host. However, *Pelecinus* has not been reared from other than *Phyllophaga* in Ontario and Quebec to date, although it is possible that it may attack larvae in soil or rotting wood.

LITERATURE CITED

1. Davis, J. J. 1919. Contributions to a knowledge of the natural enemies of *Phyllophaga*. Ill. Nat. Hist. Surv. Bull. 13, art. 5, pp. 86-87.
2. Petch, C. E. and G. H. Hammond. 1926. Parasites of white grubs in southern Quebec. 56th Ann. Rept. Ent. Soc. Ont. (1925), pp. 86-87.

*Contribution No. 2308, Division of Entomology, Science Service, Department of Agriculture, Ottawa, Canada.

THE GENUS *DINOENEMIS* BANKS (HYMENOPTERA, POMPILIDAE) *

BY J. CHESTER BRADLEY,
Cornell University, Ithaca, N. Y.

Dinoenemis Banks

1925: *Dinoenemis* Banks, subgenus of *Priocnemis*. Bull. Mus. comp. zool. Harvard univ. 67:336.
Genotype: *Pompilus (Priocnemis) fortis* Cresson, by present designation.

Malar space wanting; antennae distant from the clypeal border by a little less than the length of the pedicel; scape with erect hair beneath, dense in the males; pronotum with a long dorsal surface, rounding rather abruptly into a pronounced but not deep vertical surface, and with a short horizontal collar, all this much in *Calicurgus*, but less abrupt; upper surface of hind tibiae not carinate, but with minute elevations at the bases of spines which scarcely exceed the length of the tibial hair, and are absent at the base of the tibiae; head, thorax, propodeum, coxae and abdomen of the males more hairy than in the species of *Priocnemis*.

Although described as a subgenus, *Dinoenemis* seems to require generic status. In describing it Banks placed in it, besides the genotype, two other species, *Pompilus comparatus* Walker, nec Smith (subsequently renamed *oregona* by Banks) and *Pompilus (Priocnemis) nigripes* Cresson. But the essential characters of these two species do not agree with those of the genotype, in that they have a malar space (shorter in *nigripes* than in *oregona*), the scape of the female is without erect hair beneath; the pronotum is slopingly rounded, as in *Priocnemis*, with scarcely any dorsal surface, the hind tibiae of the female are strongly serrate, with erect scales and spines, as in *Priocnemis*, and the antennae are placed at the clypeal margin as in at least many *Priocnemis*, for example *P. conicus* (Say). It therefore seems necessary to restore these two species to *Priocnemis*.

KEY TO SPECIES

Females

- Upper portion of metapleura wrinkled; wings bronze-black, with violaceous reflection *fortis* (Cresson)
Metapleura not wrinkled; wings lightly smoky, without reflection *albopilosa* (Cresson)

Males

1. Last sternite excavated and either fringed or its surface densely hairy; hair of body black 2
Last sternite not excavated, reaching apex of last tergite, neither covered by nor surrounded with long hair; hair of body white *albopilosa* (Cresson)
2. Wings orange, the apical margin narrowly black; apical margin of last sternite fimbriate *inaequalis* (Banks)
Wings subhyaline, slightly stained with fuscous; last sternite densely hairy, but not fimbriate *fortis* (Cresson)

Dinoenemis fortis (Cresson)

1867. *Pompilus (Priocnemis) fortis* Cresson, ♀. Trans. Amer. ent. soc. 1:113.

1867. *Pompilus (Agenia) nigropilosus* Cresson, ♂. Loc. cit. 1:124.

1884. *Salix fortis* Kohl, ♀. Verh. Zool. bot. Gesellsch. Wien. 34:45.

1884. *Pseudagenia nigropilosa* Kohl. Loc. cit. p. 42.

1925. *Priocnemis (Dinoenemis) fortis* Banks. Bull. Mus. comp. Zool. Harvard univ. 67:336.

♂. Sternite VII (apparent VI) normal; sternite IX (apparent VII, the true sternite VIII being concealed) of unusual conformation, consisting of a transverse semicircle, depressed posteriorly like half of a saucer, the entire surface

*This, and a following paper on "*The Genus Cressochilus* Banks" are principally to record certain facts of synonymy, etc., and are only preliminary studies. I have made no attempt to bring material together of these genera, nor to make certain that there are not other species standing in other genera that properly belong in those discussed.

with a brush of erect hair which appears very dense when seen from the side, and yet does not entirely conceal the integument when viewed from below; certain of the genitalic structures, also densely hairy, exposed beyond the apex of sternite IX, but covered by the projecting apical portion of the last tergite.

Distribution—NEW YORK: 2 ♀♀ (types).

WEST VIRGINIA: 1 ♂ (allotype).

NORTH CAROLINA: Boone, Grandfather Mt., Highlands, Sept. (rec. by Brimley).

GEORGIA: Clayton, 1 ♀, 2000 ft. alt., May 18-26, 1911 (J. C. Bradley—Cornell University).

***Dinocnemis inaequalis* (Banks), new combination**

1917. *Cryptocheilus inaequalis* Banks, ♂. Bull. Mus. comp. zool. Harvard univ. 61:102.

♂: Sternite IX (VII) cup-shaped as in *fortis*, its apical margin strongly fimbriate with short and long setae, but its surface covered with only short, inconspicuous hair.

Distribution.—WASHINGTON: 1 ♀ (T. Kincaid—Cornell University); Camp Umatilla, 27 June '82 (T. Kincaid—type).

OREGON: Heppner, 1 ♂, Aug. 11 '07 (Nettie Currin—Cornell University); Jone, 1 ♂, July 15 '07 (Linnie Currin—Cornell University); Roseberg, on gravel bar, 1 ♂, Aug. 2 '22 (A. C. Lovett—Cornell University).

CALIFORNIA: Portola, 1 ♂, Sept. 5 '17 (R. C. Shannon—Cornell University).

***Dinocnemis albopilosa* (Cresson), new combination.**

1867. *Pompilus (Agenia) albopilosa* Cresson, ♂, Trans. Amer. ent. soc. 1:125.

1884. *Pseudagenia albopilosa* Kohl. Verh. Zool. bot. Gesellsch. Wien. 34:42.

1915. *Priocnemis fortella* Banks, ♂, ♀, Can. ent. 47:401. New synonymy.

♂: Sternite IX (VII) like that of a *Priocnemis* and wholly unlike that of the preceding species, flat, not unusually hairy, not transverse, reaching to the apex of the last tergite and concealing the phallic structures.

Except in the above mentioned characters of the male, the structure of this species is very similar to that of the preceding. In arranging *fortella* under the genus *Dinocnemis* in the collection of the Museum of Comparative Zoology Mr. Banks has recognized its generic affiliation. I have examined the holotype of *albopilosa* and the type series of *fortella* and find them identical.

Distribution.—NEW YORK: Ithaca, Jl. 22—Sept. and Otto (rec. in "A list of insects of New York").

MARYLAND: Cabin John, 1 ♂, June 30, 1911 (W. T. Davis—Cornell University).

VIRGINIA: Great Falls, June 12 (types of *fortella*).

WEST VIRGINIA: Types.

GUELPH PRINTING SERVICE

Mailed Friday, July 21, 1944.

, 1944

side,
elow;
apex
ite.

. by

dley -

ongly
short,

Camp

sity);
gravel

nivers-

hat of
to the

ure of
under
oology
lotype

list of

ll Un-